

Written Exam at the Department of Economics winter 2016

Corporate Finance Theory

Final Exam

Date: December 16, 2016

(Take-home exam: answers must be submitted before January 6, 2017, 10 AM)

This exam question consists of 8 pages in total (including this page).

Please answer all questions. Answers must be submitted in English.

You are allowed to discuss the questions with your fellow students, but you must write up your own individual answer to all questions.

Exam scripts may be checked for plagiarism. Note, in particular, that copy paste of each others' answers, or changing only a few words in sentences, etc. constitutes plagiarism.

1. Problem 1

Write 1 to 2 paragraphs for each of the following subquestions. You are welcome to use a limited number of mathematical symbols in your answer, but please do not include any explicit calculations.

- (a) Explain intuitively why a high-quality firm has a larger incentive than a low-quality firm to opt for an IPO, relative to an acquisition, in the setting of Bayar and Chemmanur (2011). Discuss how this relates to the 'IPO valuation premium puzzle' described in their paper.
- (b) Consider the framework of Malenko and Malenko (2015), and suppose that a particular sponsor is never able to provide any operational benefits through LBOs. Describe what this implies about the sponsor's ability to provide financing benefits through LBOs, in a repeated setting, and explain why.
- (c) Explain intuitively why high debt levels can make it more difficult for a firm to motivate its workers in the framework of Fahn et al. (2014), and describe how this relates to the idea of *commitment*. Choose one other article we have looked at this semester where commitment problems also play a role, and describe the main difference between the commitment problem in that article, and the one in Fahn et al. (2014).

2. Problem 2

This question is based on the static framework of DeMarzo et al. (2014), with two differences. First, whereas DeMarzo et al. (2014) consider a single firm, with one owner, one manager, and a safe/risky project, we allow for multiple firms (each with one owner, one manager, and a safe/risky project). We also allow wage payments to each manager to depend on both the cash flows he reports, as well as on the cash flows reported by managers in the other firms. Second, we assume that the state of the world ('Good' or 'Disaster') is unobservable. This implies that the wage a manager receives can only depend on cash flow reports, but not directly on the state.

The text below provides a detailed description of the problem. Keep in mind that, if we set $N = 1$, then this problem description would correspond to the static model of DeMarzo et al. (2014), except that wage payments cannot be conditioned on the realized state. When answering this question, you are expected to explicitly work with, and manipulate, the relevant mathematical expressions.

Consider a setting with $N \geq 1$ firms, and where the state of the world θ is either ‘Good’ ($\theta = G$) or ‘Disaster’ ($\theta = D$). Each firm $i \in \{1, 2, \dots, N\}$ consists of an owner and a manager (both with subscript i). Neither of them observe the state of the world, but they hold the following prior beliefs: $\mathbb{P}(\theta = G) = 1 - \delta$, and $\mathbb{P}(\theta = D) = \delta$, with $0 < \delta < 1$.

The timing of the game is as followed. First, the state of the world is realized. Second, in each firm i , owner i offers a contract $w_i(r_1, \dots, r_N)$ to manager i . This contract specifies the wage w_i the manager will later receive, conditional on the cash flow he reports, r_i , and the cash flows reported by other managers, $(r_1, \dots, r_{i-1}, r_{i+1}, \dots, r_N)$ (more details below). Third, manager i observes this contract and chooses a project $p_i \in \{S, R\}$, where S stands for ‘Safe’ and R stands for ‘Risky’. Fourth, the cash flow of this project is realized, which we denote by $Y_i(p_i, \theta)$. Fifth, manager i observes the cash flow $Y_i(p_i, \theta)$ and sends a public report about it, r_i . Sixth, owner i observes the set of reports from all N managers, (r_1, \dots, r_N) , and pays manager i the wage $w_i(r_1, \dots, r_N)$ specified under the contract. Finally, payoffs are realized and the game ends.

The realized cash flow $Y_i(p_i, \theta)$ can take on one of three values: 1, 0, and $-D < 0$. The probability of these different values depends both on the project $p_i \in \{S, R\}$ chosen by manager i , and on the state $\theta \in \{G, D\}$, in the following way:

Safe Project, Good State:

- $\mathbb{P}(Y_i = 1 | p_i = S, \theta = G) = \frac{\mu}{1-\delta}$
- $\mathbb{P}(Y_i = 0 | p_i = S, \theta = G) = 1 - \frac{\mu}{1-\delta}$
- $\mathbb{P}(Y_i = -D | p_i = S, \theta = G) = 0$

Safe Project, Disaster State:

- $\mathbb{P}(Y_i = 1 | p_i = S, \theta = D) = 0$
- $\mathbb{P}(Y_i = 0 | p_i = S, \theta = D) = 1$
- $\mathbb{P}(Y_i = -D | p_i = S, \theta = D) = 0$

Risky Project, Good State:

- $\mathbb{P}(Y_i = 1 | p_i = R, \theta = G) = \frac{\mu+\rho}{1-\delta}$
- $\mathbb{P}(Y_i = 0 | p_i = R, \theta = G) = 1 - \left(\frac{\mu+\rho}{1-\delta}\right)$
- $\mathbb{P}(Y_i = -D | p_i = R, \theta = G) = 0$

Risky Project, Disaster State:

- $\mathbb{P}(Y_i = 1 | p_i = R, \theta = D) = 0$
- $\mathbb{P}(Y_i = 0 | p_i = R, \theta = D) = 0$
- $\mathbb{P}(Y_i = -D | p_i = R, \theta = D) = 1$

where $0 < \mu < 1 - \delta$, and $0 < \rho < 1 - \delta - \mu$. Conditional on the state and project selection, the realized cash flow for manager i is independent of the realized cash flows of the other managers.

We will assume that manager i must truthfully report the realized cash flow if it is 0 or $-D$, i.e. $r_i = Y_i$ whenever $Y_i \in \{0, -D\}$. However, if the realized cash flow is 1, then manager i can choose to truthfully report, $r_i = Y_i = 1$, or to instead report $r_i = 0$ and divert cash. The manager's private benefit from diverting cash is λ , where $0 < \lambda < 1$.

Payoffs are as follows. If manager i reports truthfully, then his payoff is equal to the wage he receives: $\pi_i^M = w(r_1, \dots, r_N | r_i = Y_i)$. If manager i does not report truthfully, then his payoff is just the private benefit of diverting cash: $\pi_i^M = \lambda$. (Aside: Formally speaking, it would be more reasonable to assume that this payoff would equal $w_i(r_1, \dots, r_N | r_i = 0) + \lambda$, hence the private benefit of diverting cash, plus the wage. But we will assume that the payoff is simply $\pi_i^M = \lambda$ if the manager diverts cash, to keep the problem tractable.) The payoff to owner i is equal to the cash flow reported by manager i , minus the wage paid: $\pi_i^O = r_i - w_i(r_1, \dots, r_N)$. The manager is protected by limited liability, so that wages must be non-negative: $w_i(r_1, \dots, r_N) \geq 0$, for any vector of reports (r_1, \dots, r_N) . You can also assume that the condition $\delta D - \rho > 0$ holds.

- (a) Find the expected cash flows (from an ex ante perspective) generated by the safe project, and compare them to the expected cash flows generated by the risky project. Show which of these expected cash flows is higher (i.e. which project is more efficient).

We now concentrate on the incentives of the owner and manager in a specific firm i . Suppose that owner i and manager i both expect that managers in all $N - 1$ other firms will choose the safe project and truthfully report cash flows. Moreover, suppose that owner i offers manager i the following contract, which we will call 'contract \mathbb{W} ': $w_i(r_1, \dots, r_N) = \lambda$ if $r_i = 1$; $w_i(r_1, \dots, r_N) = w > 0$ if $r_1 = \dots = r_N = 0$; and $w_i(r_1, \dots, r_N) = 0$ otherwise. That is, if manager i reports a cash flow of 1, then he will receive a wage of λ , no matter what. But if manager i reports a cash flow of 0, then his wage will depend on the other managers' reports. Specifically, manager i will receive a wage of w if all other managers also report zero cash flow, and a wage of 0 if at least one manager $j \neq i$ reports a cash flow of 1. Owner i specifies the exact value of w when offering the contract; our notation reflects the fact that w can be set at any positive value.

- (b) Consider, broadly speaking, how the main features of contract \mathbb{W} compare to DeMarzo et al. (2014)'s proposal of how to implement their 'optimal contract conditional on the disaster state' in practice (see Proposition 3, and the subsection on Implementation that immediately follows). Briefly describe the main similarity and the main difference.

- (c) Argue that under contract \mathbb{W} , manager i always has an incentive to report cash flows truthfully.
- (d) Show that under contract \mathbb{W} , manager i 's expected payoff from choosing the safe project is

$$\pi_i^M(S) = \delta w + (1 - \delta) \left[\lambda \frac{\mu}{1 - \delta} + w \left(1 - \frac{\mu}{1 - \delta} \right)^N \right]$$

- (e) Show that under contract \mathbb{W} , manager i 's expected payoff from choosing the risky project is

$$\pi_i^M(R) = (1 - \delta) \left[\lambda \left(\frac{\mu + \rho}{1 - \delta} \right) + w \left(1 - \frac{\mu}{1 - \delta} \right)^{N-1} \left(1 - \left(\frac{\mu + \rho}{1 - \delta} \right) \right) \right]$$

- (f) Describe intuitively why manager i 's incentive to choose the safe project, relative to the risky project, will increase if the owner sets a larger value of w . Then show explicitly that the manager will choose the safe project if and only if $w \geq w^*$, where

$$w^* = \frac{\lambda \rho}{\delta + \rho \left(1 - \frac{\mu}{1 - \delta} \right)^{N-1}}$$

- (g) Suppose that owner i wants to use contract \mathbb{W} to implement the safe project, but also wants to minimize expected wage payments to the manager while doing so. Explain what value of w the owner should set. That is, what is the optimal value of w (conditional on implementing the safe project) from the owner's perspective?
- (h) Using (d) and your answer from part (g), write down an explicit expression for expected wage payments to manager i under contract \mathbb{W} , with w set at the optimal value from the owner's perspective. Now take the limit as N tends to infinity. What value does the expected wage payments approach in this limit? *Hint: when taking the limit, use the fact that $\mu < 1 - \delta$.*
- (i) Compare the expected wage payments derived in part (h), in the limit as N tends to infinity, to those from Proposition 3 of DeMarzo et al. (2014): $(\mu + \rho)\lambda$. Is one of these expected wage payments higher/lower than the other? Comment on what the intuition is for this result, and what it implies for implementing DeMarzo et al. (2014)'s 'optimal contract conditional on the disaster state' in practice.

3. Problem 3

Read the news story 'Big Oil Companies Binge on Debt' from the Wall Street Journal (August 24, 2016), the text of which is reproduced following this question. Please discuss which theoretical ideas from the articles seen this semester can generate the most insight into the phenomenon described in the news story (*you can consider, for example, the possible causes of the rise in debt levels described in the story, and/or its possible consequences*). For the theoretical ideas that you mention, comment on whether the key modelling assumptions behind these ideas are plausible in this particular real-life setting. You are welcome to seek out more information about the companies in question.

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<http://www.wsj.com/articles/largest-oil-companies-debts-hit-record-high-1472031002>

BUSINESS

Big Oil Companies Binge on Debt

Exxon, Shell, BP and Chevron have combined debt of \$184 billion amid two-year slump



Pumping jacks at the Chevron section of the Kern River Oil Field near Bakersfield, Calif. Chevron said earlier this year that its higher debt levels were expected. PHOTO: AGENCE FRANCE-PRESSE/GETTY IMAGES

By **SELINA WILLIAMS** and **BRADLEY OLSON**

Updated Aug. 24, 2016 6:13 p.m. ET

Some of the world's largest energy companies are saddled with their highest debt levels ever as they struggle with low crude prices, raising worries about their ability to pay dividends and find new barrels.

Exxon Mobil Corp., Royal Dutch Shell PLC, BP PLC and Chevron Corp. hold a combined net debt of \$184 billion—more than double their debt levels in 2014, when oil prices began a steep descent that eventually bottomed out at \$27 a barrel earlier this year. Crude prices have rebounded since, but still hover near \$50 a barrel.

The soaring debt levels are a fresh reminder of the toll the two-year price slump has taken on the oil industry. Just a decade ago, these four companies were hauled before Congress to explain “windfall profits” but now can't cover expenses with normal cash flow.

Executives at BP, Shell, Exxon and Chevron have assured investors that they will generate enough cash in 2017 to pay for new investments and dividends, but some shareholders are skeptical. In the first half of 2016, the companies fell short of that goal by \$40 billion, according to a Wall Street Journal analysis of their numbers.

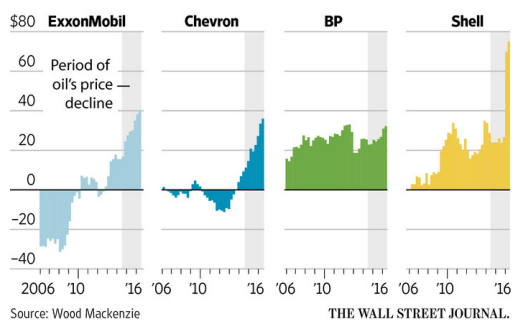
“Eventually something will give,” said Michael Hulme, manager of the \$550 million Carmignac Commodities Fund, which holds stakes in Shell and Exxon. “These companies won't be able to maintain the current dividends at \$50 to \$60 oil—it's unsustainable.”

The debt is piling up despite cuts of billions of dollars on new projects and current operations. Repaying the loans could weigh the companies down for years, crimping their ability to make investments elsewhere and keep pumping ever more oil and gas.

Heavier Load

The world's biggest oil companies are taking on more debt as they struggle with low crude prices.

Net debt in billions, quarterly data



The companies spent more than 100% of their profits on dividends last year. This year, the problem got worse. In the April-to-June period, Exxon paid \$3.1 billion in dividends and had just \$1.7 billion in net income, according to S&P Global Market Intelligence. Shell paid \$1.26 billion in interest in the first half of 2016, compared with \$726 million in the same period a year earlier.

“They are just not spending enough to boost production,”

said Jonathan Waghorn, co-portfolio manager in London at Guinness Atkinson Asset Management Inc. who helps oversee more than \$400 million across a range of energy funds, including shares in Exxon, BP, Chevron and Shell.

The oil companies say they have many tools to deploy to help defray debt, including selling assets and offering shareholders more shares instead of a cash dividend, as well as continuing to cut costs. Record-low interest rates are helping ease some of the pain.

They also say the steep levels of debt are temporary as the companies restructure, and the debt will fall when oil prices rise.

‘These companies won’t be able to maintain the current dividends at \$50 to \$60 oil—it’s unsustainable.’

—Michael Hulme, manager of the Carmignac Commodities Fund

“We are in a transitional stage in 2016,” said Shell Chief Executive Ben van Beurden during last month’s earnings disclosures. The company reported a rise in net debt to over \$75 billion at the end of the second quarter, in large part because of its acquisition of BG Group PLC.

BP has said it expects to be able to pay for its operations, make new investments and meet its dividend at an oil price of between \$50 and \$55 a barrel next year.

But analysts and investors say the oil slump is making it harder than ever for companies to raise money with asset sales to pay off debt. Handing out more shares to shareholders is only storing up the dividend problem for the future when the companies will need to pay up. Even the boost many companies got from bumper profits from their refining divisions—which tend to do well when prices are low—looks to be coming to an end as a glut of gasoline erodes fuel prices, say investors and analysts.

Still, some funds see BP, Shell, Exxon and Chevron as big enough to weather problems for the next year and a half. Wilmington Trust has reduced its exposure to energy companies it deems more risky in favor of other corporate debt. But the firm remains invested in debt issued by BP, Chevron and Shell

“They’re so big, they can diversify, they have more levers to push and pull in terms of shoring up their creditworthiness,” said Wilmer Stith, senior fixed-income portfolio manager at Wilmington Trust, which has \$73 billion in assets under management.

Only another long period of oil below \$40 a barrel would pose a challenge that could prompt dividend cuts, said Iain Reid, senior oil analyst at Macquarie Capital. A Goldman Sachs report this week projected oil prices remaining between \$45 and \$50 a barrel for much of the next year.

“The question is, can they get through this year and next without doing something radical like cutting dividends?” said Iain Reid, senior oil analyst at Macquarie Capital.

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The rise in net debt has helped push these companies' ratio of net debt to equity to the highest level in years, which influences the ratings given by

credit agencies. S&P has already downgraded Shell, Chevron, Exxon and BP, though they all remain highly rated.

Shell's debt-to-equity ratio is at 28% and Chief Financial Officer Simon Henry said last month it could even reach its targeted maximum of 30%. BP's gearing is over 25%, while Chevron's is 20% and Exxon's is around 18%.

By comparison, in 2012, Shell's gearing was around 10%, and Exxon's was 1.2%. Back in 2005, when oil prices were climbing steadily, Exxon had no debt, and its profits were so high that its executives and those from other big oil companies were called to testify in front of the U.S. Senate about their so-called windfall profits.

Chevron's Chief Financial Officer Patricia Yarrington said in April that the company's higher levels of debt were expected. "We could handle that if it's temporary," she said.

Much of the new debt has been in corporate bonds. Exxon, for instance, issued \$12 billion in debt in February. Two months later, the company was downgraded by S&P Global Ratings, losing the triple-A credit rating that it had held since 1930.

Exxon Chief Executive Rex Tillerson has assured investors that Exxon remains committed to paying its dividend.

The company has increased shareholder payments for 34 straight years, although those increases have been modest in the past two years. Mr. Tillerson and others have noted that Exxon has the ability to borrow further. If anything, the company has signaled a willingness to go further into debt for strategic opportunities, such as buying assets, including InterOil Corp., a small company focused on gas exports in Papua New Guinea that Exxon agreed to acquire for an estimated \$2.5 billion in July

"We're not going to forgo attractive opportunities," said Jeff Woodbury, Exxon's vice president of investor relations, on an investor call last month.

—Heather Gillers in New York contributed to this article.

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Corrections & Amplifications:

In the first half of 2016, the companies fell short of that goal by \$40 billion, according to a Wall Street Journal analysis of their numbers. An earlier version of this article incorrectly stated that it was the first half of 2015. Aug. 24, 2016

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